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Halila et al.

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(54) **METHOD FOR PROVIDING CONCENTRICITY OF PILOT FUEL ASSEMBLY IN A COMBUSTOR**

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(21) Appl. No.: **09/903,952**

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Related U.S. Application Data

(62) Division of application No. 09/213,400, filed on Dec. 16, 1998, now abandoned.

(51) **Int. Cl.**[7] **F02C 7/22**
(52) **U.S. Cl.** **60/772**; 60/798; 60/748; 60/39.826
(58) **Field of Search** 60/772, 748, 740, 60/261, 796, 798, 800, 746, 747, 39.826

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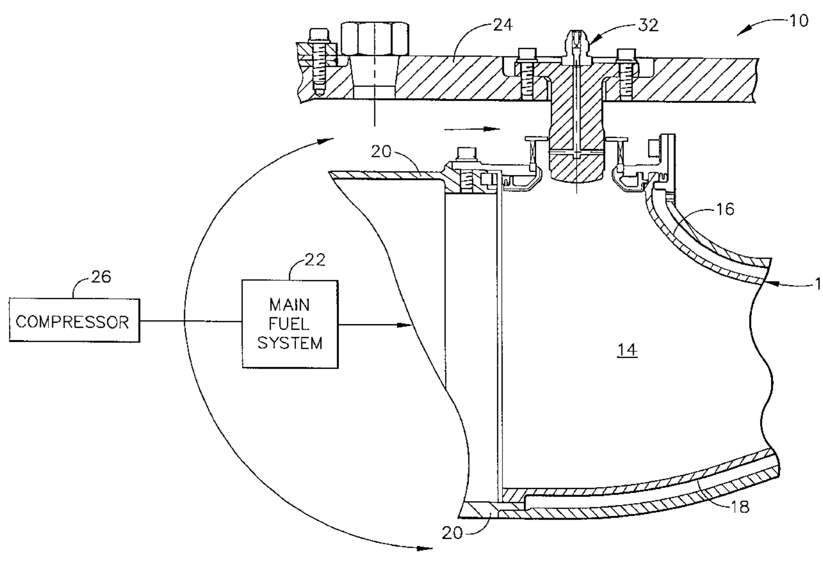
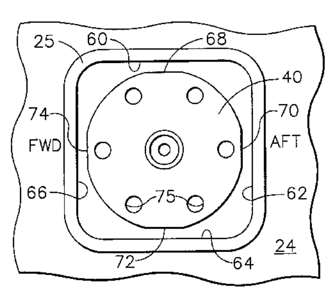
(57) **ABSTRACT**

Concentric installation of a pilot fuel assembly in an opening in a gas turbine combustor casing is achieved by providing a boss having at least two flat surfaces which are perpendicular to each other on the combustor casing surrounding the opening and a mounting flange having at least two flat surfaces which are perpendicular to each other on the pilot fuel assembly. The pilot fuel assembly is concentrically installed to the combustor casing by inserting the assembly into the combustor casing opening, and moving the pilot fuel assembly as far as it will go in a first direction substantially parallel to one of the flat boss surfaces. The distance between the other flat boss surface and one of the flat flange surfaces is then taken. Next, the pilot fuel assembly is moved in the direction opposite the first direction, at which point, the distance between the same two flat surfaces is again measured. Lastly, the pilot fuel assembly is located at a position where the distance between the two measuring surfaces is equal to the average of the first and second measurements. If desired, these steps can be repeated back and forth along an axis perpendicular to the first and second directions.

15 Claims, 7 Drawing Sheets





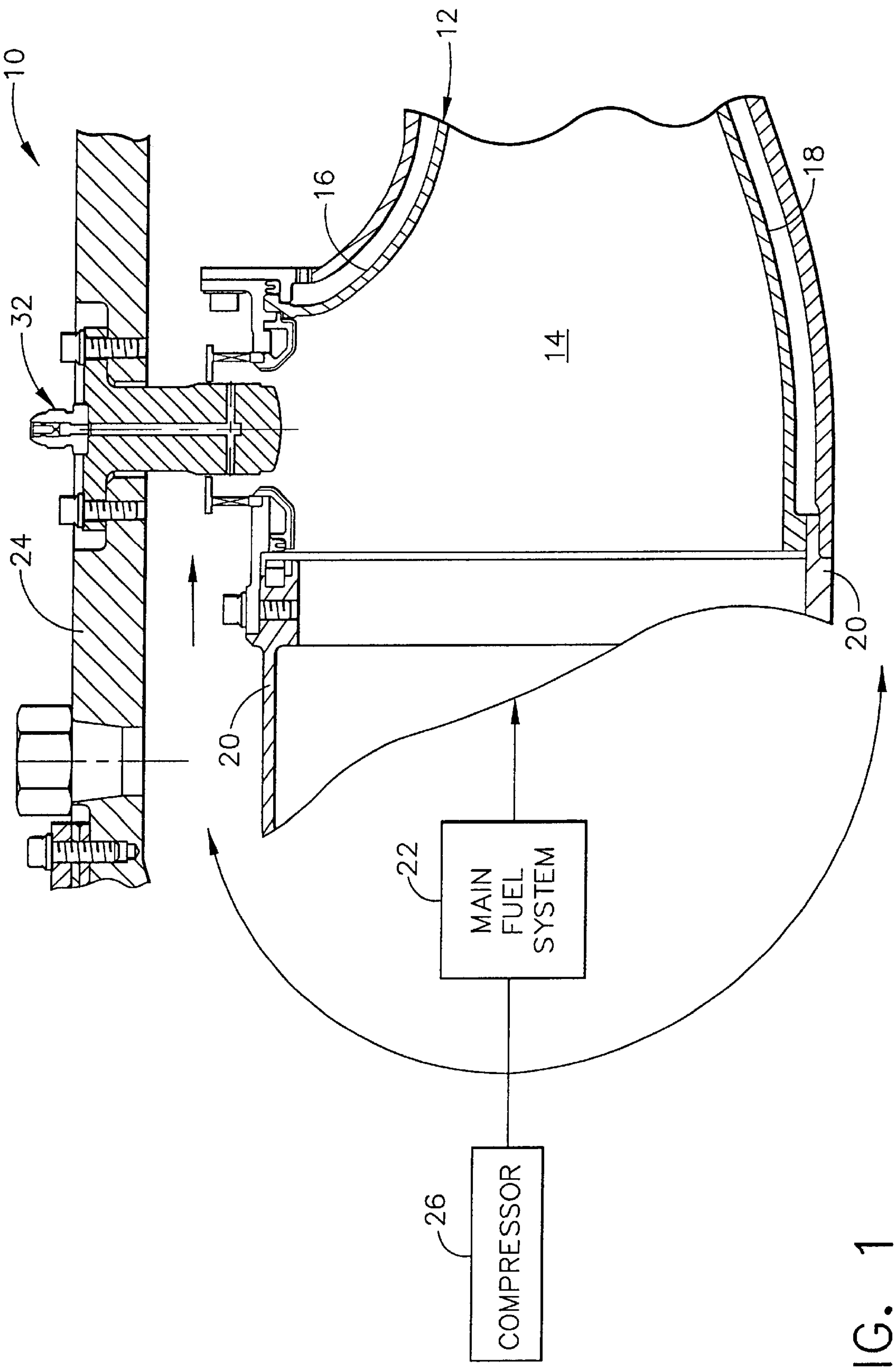


FIG. 1

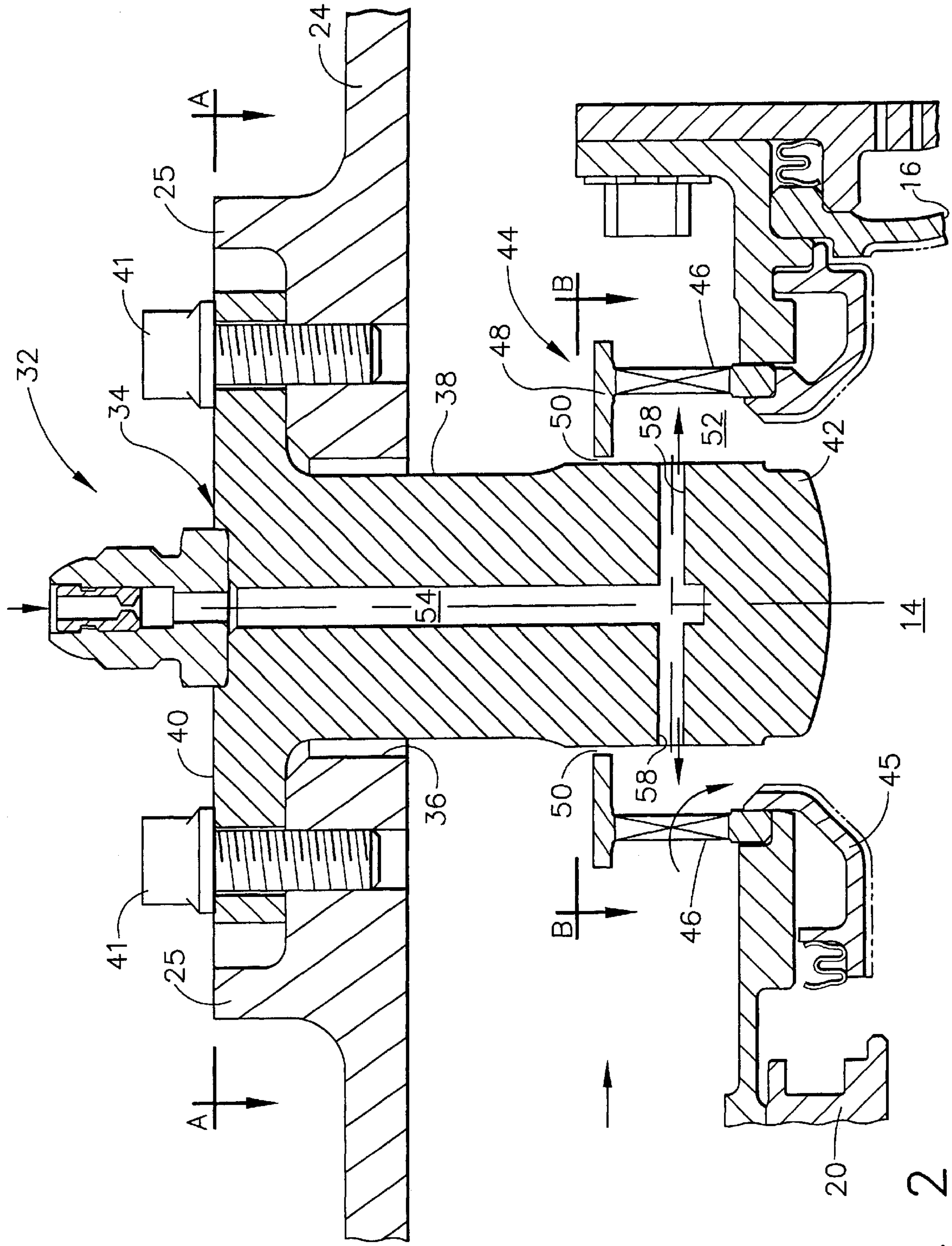

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FIG. 2

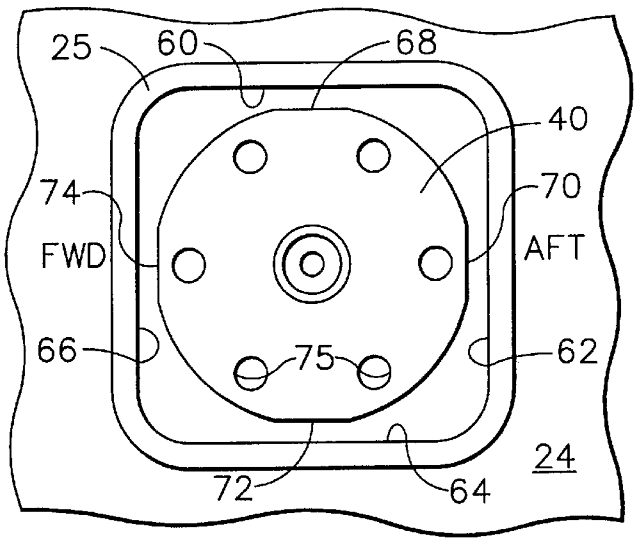

FIG. 3

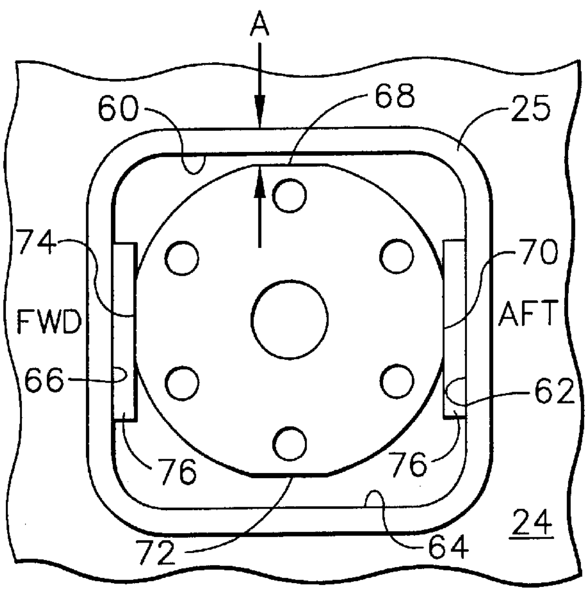

FIG. 4

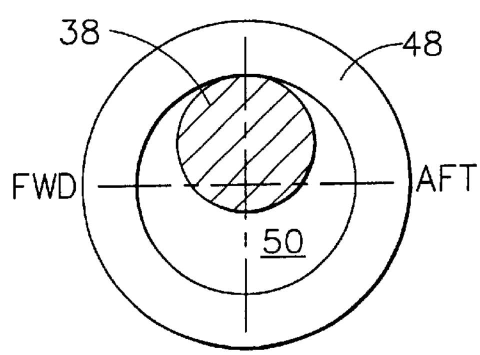

FIG. 5

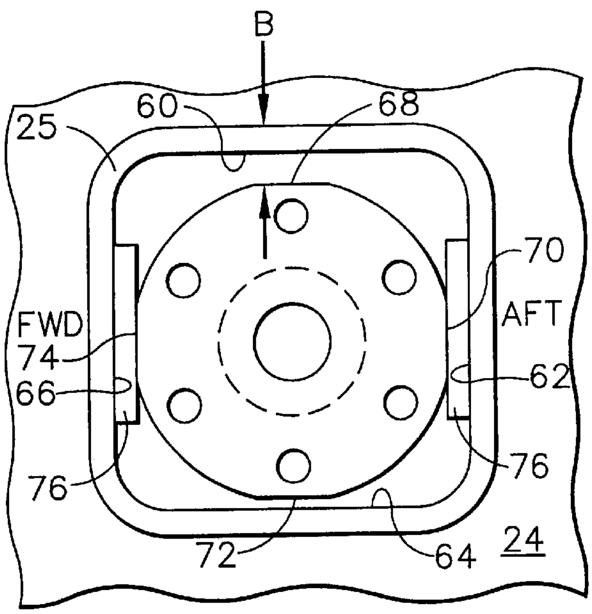

FIG. 6

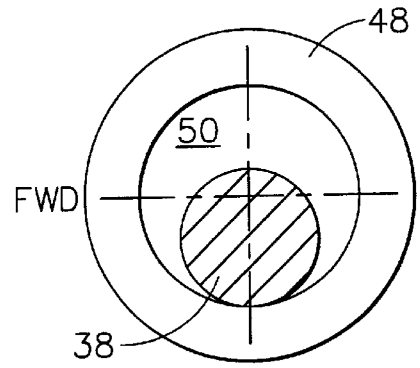

FIG. 7

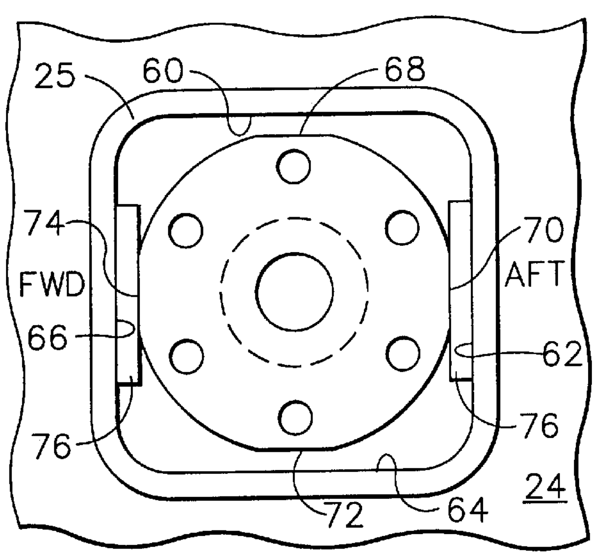

FIG. 8

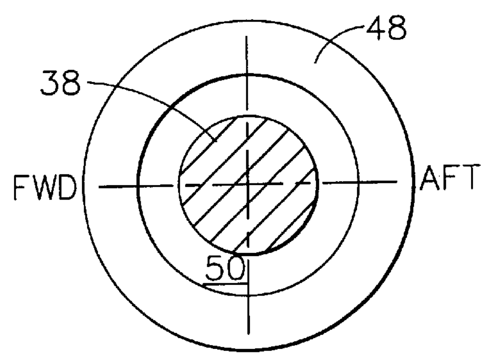

FIG. 9

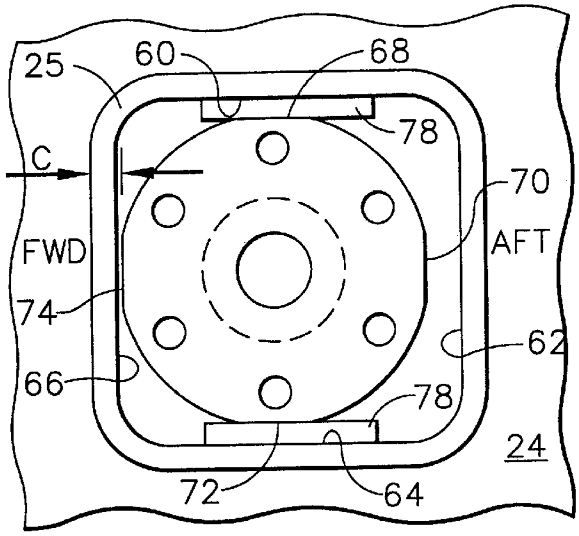

FIG. 10

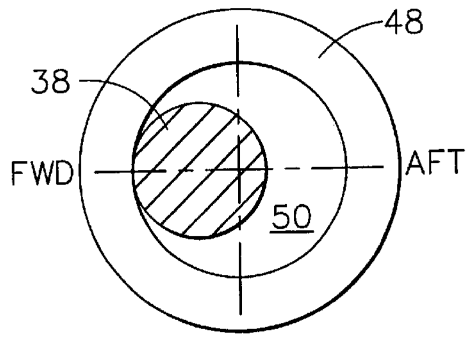

FIG. 11

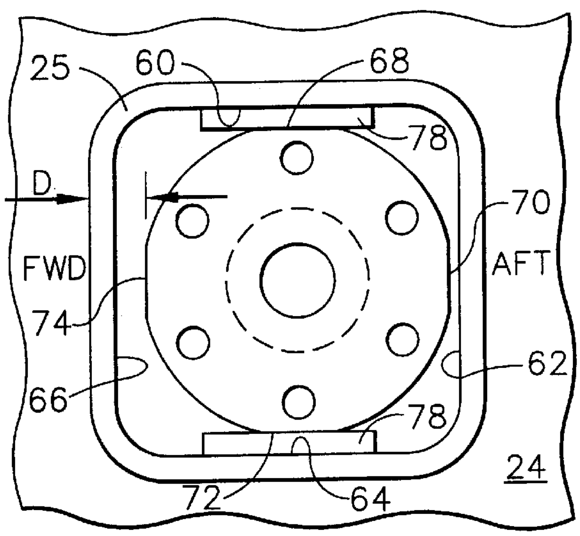

FIG. 12

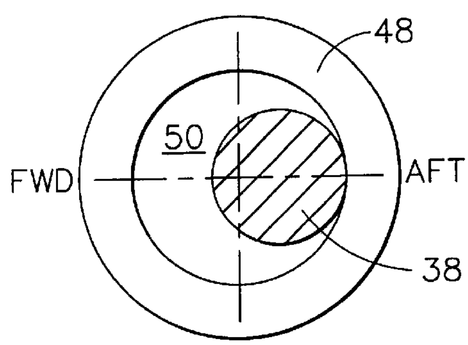

FIG. 13

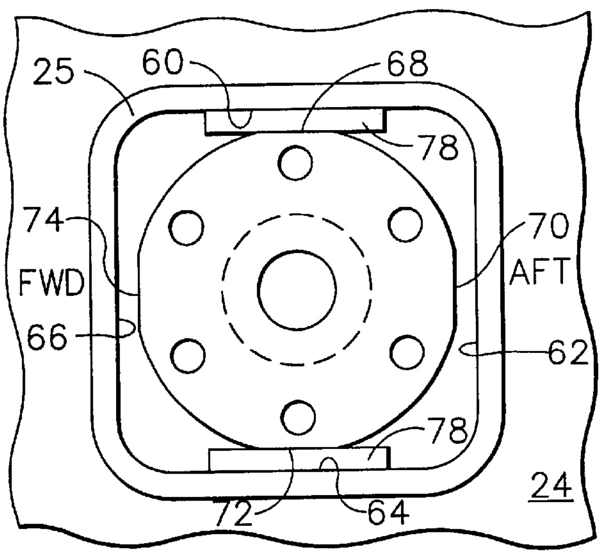

FIG. 14

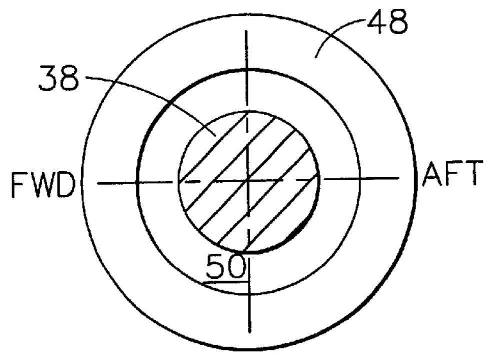

FIG. 15

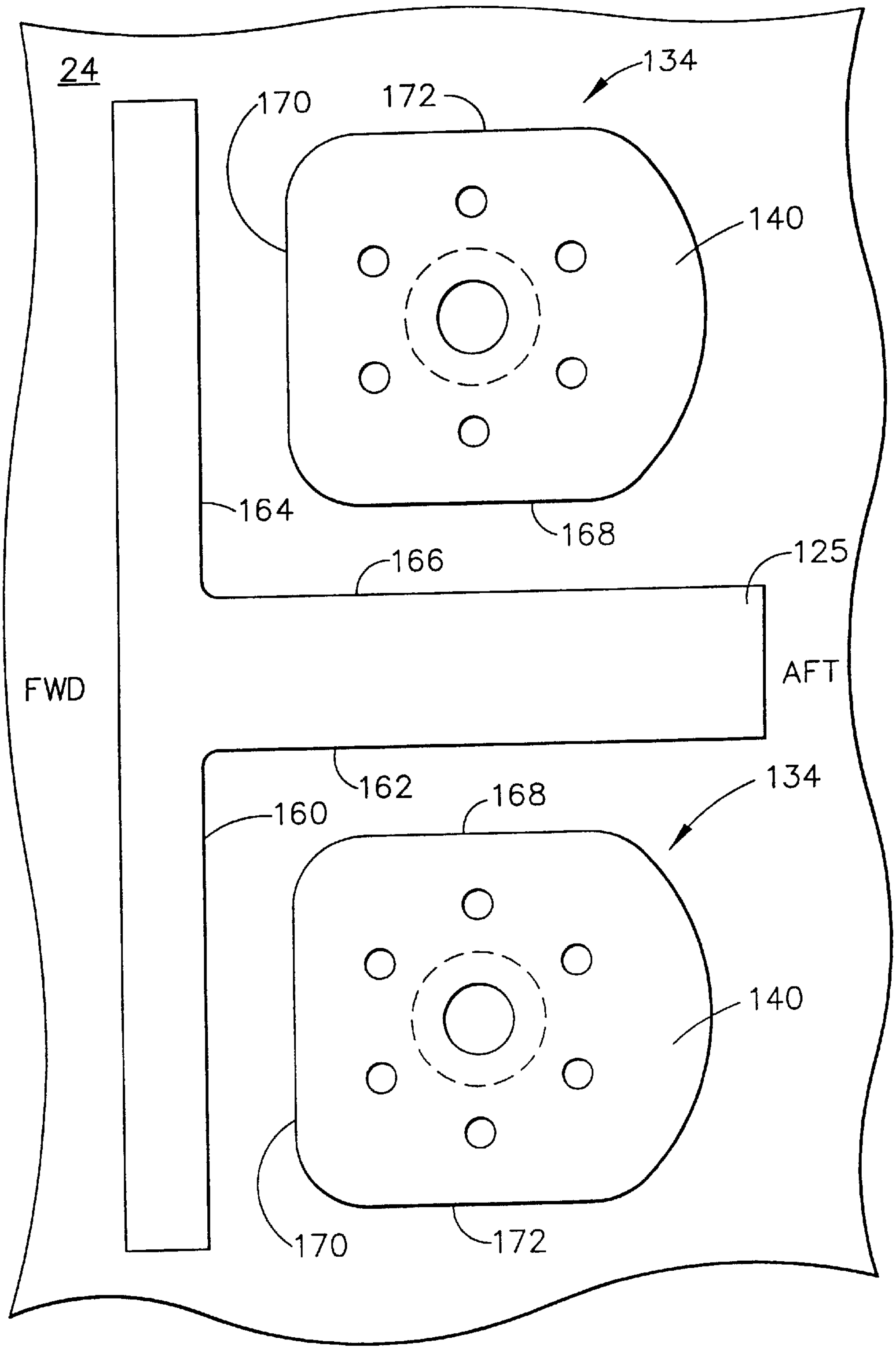
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FIG. 16

METHOD FOR PROVIDING CONCENTRICITY OF PILOT FUEL ASSEMBLY IN A COMBUSTOR

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a division of application Ser. No. 09/213,400, filed Dec. 16, 1998, now abn.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH & DEVELOPMENT

The U.S. Government may have certain rights in this invention pursuant to contract number NAS3-27235 awarded by NASA.

BACKGROUND OF THE INVENTION

This invention relates generally to combustors for gas turbine engines and more particularly to properly and repeatedly positioning all pilot fuel assemblies in such combustors.

A gas turbine engine includes a compressor that provides pressurized air to a combustor wherein the air is mixed with fuel and ignited in a combustion zone for generating high temperature gases. These gases flow downstream to one or more turbine stages that extract energy therefrom to power the compressor and provide useful work such as powering an aircraft in flight or land based engines. It is desirable to reduce exhaust emissions produced by the combustion process. This is particularly true for the new generation of supersonic transport, referred to as High Speed Civil Transport (HSCT), that is currently under development. For HSCT to be viable, emission levels, particularly NO_X, must be significantly reduced relative to present aircraft while maintaining high combustion efficiencies. Efforts to reduce emissions in the HSCT have led to the development of a combustor having a plurality of pilot fuel systems that direct a swirled mixture of fuel and air radially into the combustion zone.

Such pilot fuel systems typically include a pilot fuel assembly and a swirler assembly. A major assembly requirement for this type of pilot fuel system is to maintain concentricity between the pilot fuel assembly and its corresponding swirler assembly. Since the air exiting from the swirler assembly is swirling at a defined angular discharge, a static pressure imbalance can develop within the swirling chamber if the concentricity is not maintained. This results in local static pressure variations that can cause the fuel/air mixture to pre-ignite prior to its discharge into the combustion chamber. This is a potentially hazardous condition in locations where combustion is undesirable. However, because it is mounted from outside of the outer combustor casing, installation of the pilot fuel assembly is a blind process. Thus, concentricity between the pilot fuel assembly and the swirler assembly cannot be maintained or even determined. In addition, concentricity variations from one pilot fuel system to another will exist, resulting in non-conformance in minimizing pre-combustion. The problem is compounded by the dimensional stack-up for the various pilot fuel system components that results from the manufacturing tolerances.

Accordingly, there is a need for a repeatable method of providing concentricity for a pilot fuel system in a gas turbine combustor. There is also a need for a combustor having a pilot fuel system configured in such a manner that permits concentric installation and minimizes concentricity variations.

SUMMARY OF THE INVENTION

The above-mentioned needs are met by the present invention which provides a gas turbine combustor having a combustor casing with an opening formed therein and a boss formed thereon surrounding the opening. A pilot fuel assembly having a mounting flange is disposed in the opening, with the mounting flange being encircled by the boss. Both the boss and the mounting flange are provided with at least two flat surfaces that are perpendicular to each other. The pilot fuel assembly is concentrically installed to the combustor casing by inserting the assembly into the combustor casing opening, and moving the pilot fuel assembly as far as it will go in a first direction substantially parallel to one of the flat boss surfaces. The distance between the other flat boss surface and one of the flat flange surfaces is then taken. Next, the pilot fuel assembly is moved in the direction opposite the first direction, at which point, the distance between the same two flat surfaces is again measured. Lastly, the pilot fuel assembly is located at a position where the distance between the two measuring surfaces is equal to the average of the first and second measurements. If desired, these steps can be repeated back and forth along an axis perpendicular to the first and second directions.

Other objects and advantages of the present invention will become apparent upon reading the following detailed description and the appended claims with reference to the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the concluding part of the specification. The invention, however, may be best understood by reference to the following description taken in conjunction with the accompanying drawing figures in which:

FIG. **1** is a sectional view of a combustor having a pilot fuel system that is concentrically installed in a gas turbine engine.

FIG. **2** is an enlarged sectional view of the pilot fuel system of FIG. **1**.

FIG. **3** is a sectional view taken along line A—A of FIG. **2** showing the relationship between the flange of the pilot fuel system and the boss formed on the combustor casing.

FIG. **4** is a sectional view taken along line A—A of FIG. **2** showing the relationship between the flange and the boss with the pilot fuel assembly moved to a first position.

FIG. **5** is a sectional view taken along line B—B of FIG. **2** showing the relationship between the cylindrical body and the cap plate of the pilot fuel system with the pilot fuel assembly in the first position.

FIG. **6** is a sectional view taken along line A—A of FIG. **2** showing the relationship between the flange and the boss with the pilot fuel assembly moved to a second position.

FIG. **7** is a sectional view taken along line B—B of FIG. **2** showing the relationship between the cylindrical body and the cap plate with the pilot fuel assembly in the second position.

FIG. **8** is a sectional view taken along line A—A of FIG. **2** showing the relationship between the flange and the boss with the pilot fuel assembly moved to a centered position.

FIG. **9** is a sectional view taken along line B—B of FIG. **2** showing the relationship between the cylindrical body and the cap plate with the pilot fuel assembly in the centered position.

FIG. **10** is a sectional view taken along line A—A of FIG. **2** showing the relationship between the flange and the boss with the pilot fuel assembly moved to a third position.

FIG. **11** is a sectional view taken along line B—B of FIG. **2** showing the relationship between the cylindrical body and the cap plate with the pilot fuel assembly in the third position.

FIG. **12** is a sectional view taken along line A—A of FIG. **2** showing the relationship between the flange and the boss with the pilot fuel assembly moved to a fourth position.

FIG. **13** is a sectional view taken along line B—B of FIG. **2** showing the relationship between the cylindrical body and the cap plate with the pilot fuel assembly in the fourth position.

FIG. **14** is a sectional view taken along line A—A of FIG. **2** showing the relationship between the flange and the boss with the pilot fuel assembly moved to a centered position.

FIG. **15** is a sectional view taken along line B—B of FIG. **2** showing the relationship between the cylindrical body and the cap plate with the pilot fuel assembly in the centered position.

FIG. **16** is a partial top view of another embodiment of a combustor having adjacent pilot fuel assemblies sharing a common mounting flange.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings wherein identical reference numerals denote the same elements throughout the various views, FIG. **1** shows a low emissions combustor **10** of the type suitable for use in a gas turbine engine and including a hollow body **12** defining a combustion chamber **14** therein. Hollow body **12** is generally annular in form and is comprised of an outer liner **16** and an inner liner **18**. A dome **20** is mounted to the upstream end of hollow body **12** and houses a main fuel system **22**. Compressed air is supplied from a compressor **26**. As shown schematically in FIG. **1**, the compressed air branches into three main flows. The first portion goes to main fuel system **22**, where it is mixed with fuel and then discharged into combustion chamber **14**. A second portion is directed to an inner region of combustor **10** where it is used to cool inner liner **18** and turbomachinery further downstream. A third portion is directed to an outer region of combustor **10** where it is used to supply a pilot fuel system **32** described in more detail below and to cool outer liner **16** and turbomachinery further downstream. Hollow body **12** is enclosed by a suitable combustor casing **24**.

A pilot fuel system **32** is mounted to casing **24**, aft of dome **20**. While only one pilot fuel system **32** is shown in FIG. **1** for clarity of illustration, it should be noted that a plurality of such pilot fuel systems **32** can be disposed circumferentially about combustor **10** at the same axial location slightly downstream of dome **20**. The number of pilot fuel systems depends on the size of the combustor. Pilot fuel system **32** is directed radially inward so as to inject a swirled mixture of fuel and air radially into combustion chamber **14**.

As best seen in FIG. **2**, pilot fuel system **32** includes a pilot fuel assembly **34** disposed in an opening **36** in casing **24**. Pilot fuel assembly **34** includes a substantially cylindrical body **38** having a mounting flange **40** formed at one end thereof for fastening pilot fuel assembly **34** to casing **24** with bolts **41**. Flange **40** is encircled by a boss **25** formed on casing **24** around opening **36**. A heat shield **42** is formed on the other end of cylindrical body **38**. Pilot fuel system **32** also includes a swirler assembly **44** that is mounted between outer liner **16** and dome **20**. Pilot fuel assembly **34** is positioned in opening **36** so that cylindrical body **38** is located within swirler assembly **44**. The space between swirler assembly **44** and cylindrical body **38** defines a tangential swirling chamber **52**. Swirler assembly **44** includes a pilot outer liner **45** and a plurality of circumferentially-spaced swirl vanes **46** fixedly joined to a cap plate **48**. Cap plate **48** has a circular aperture **50** formed therein for receiving cylindrical body **38**. The purpose of cap plate **48** is to provide an enclosure for the swirling air that allows it to exit into combustion chamber **14**. Pilot fuel assembly **34** includes a fuel passage **54** extending longitudinally through body **38** along its longitudinal axis through which fuel is delivered. The cylindrical body **38** also includes ports **58** in fluid communication with passage **54**. Thus, fuel is injected into tangential swirling chamber **52**, where it is mixed with the swirling air. This fuel/air mixture exits into combustion chamber **14** where it ignites and forms high temperature gases.

Referring now to FIG. **3**, it is seen how boss **25** encircles flange **40** of pilot fuel assembly **34**. Boss **25** forms a substantially rectangular shape having four flat surfaces, referred to herein as first boss surface **60**, second boss surface **62**, third boss surface **64** and fourth boss surface **66**. Each of the boss surfaces **60–66** extends radially beyond and perpendicular to the outer surface of casing **24**. Adjacent boss surfaces are perpendicular to each other, while opposite boss surfaces are parallel to one another. Preferably, parallel boss surfaces **60** and **64** are aligned so as to be parallel to the combustor casing's longitudinal axis, which means that boss surfaces **62** and **66** are tangential or perpendicular to the longitudinal axis, with boss surface **62** being disposed aft of boss surface **66**.

The perimeter of mounting flange **40** defines an essentially circular shape but includes four flat surfaces, referred to herein as first flange surface **68**, second flange surface **70**, third flange surface **72** and fourth flange surface **74**. Flange **40** also includes a number of bolt holes **75** that receive bolts **41** for fastening pilot fuel assembly **34** to casing **24**. Similarly to the boss surfaces, adjacent flange surfaces are perpendicular to each other, while opposite flange surfaces are parallel to one another. Flange **40** is sized so that when it is located within boss **25**, there is plenty of clearance between each of the boss surfaces **60–66** and the respective nearest one of the flange surfaces **68–74**.

Referring now to FIGS. **4–9** a first embodiment of a method for concentrically installing pilot fuel assembly **34** in combustor casing **24** is illustrated. Pilot fuel assembly **34** is initially inserted into opening **36** so that cylindrical body **38** is located within swirler assembly **44**, and flange **40** is located within boss **25**. Pilot fuel assembly **34** is oriented so that each flange surface **68–74** is adjacent to, and substantially parallel to, a corresponding one of the boss surfaces **60–66**. At this point, the relative position of cylindrical body **38** with respect to swirler assembly **44** is unknown. The next step is to move pilot fuel assembly **34** as far as it will go in a first direction substantially parallel to one of the boss surfaces **60–66**. For the purposes of illustration, the first direction is the tangential direction toward boss surface **60** and parallel to boss surfaces **62** and **66**; however, it should be noted that the first direction can be in any direction that is parallel to one of the boss surfaces.

By moving pilot fuel assembly **34** as far as it will go in the first direction toward boss surface **60**, cylindrical body **38** will come into contact with circular aperture **50** of cap plate **48**, as shown in FIG. **5**. Because of the circular configuration

of aperture **50**, forcing pilot fuel assembly **34** as far as it can go in the first direction will cause it to become centered in the axial direction; i.e., by seeking the farthest point in the tangential direction, pilot fuel assembly **34** will be centered between the forward-most and aft-most points of aperture **50**. Next, a pair of guide bars **76** is used to maintain the axial position of pilot fuel assembly **34**, as shown in FIG. **4**. One of the guide bars **76** is disposed in the gap defined by boss surface **62** and flange surface **70**, and the other guide bar **76** is disposed in the gap defined by boss surface **66** and flange surface **74**. Guide bars **76** are preferably elongated hexahedral members having a width that matches the width of the gap in which they are disposed. In this way, pilot fuel assembly **34** is prevented from moving in either the fore or aft axial directions but allowed to move in either tangential direction by virtue of flange surfaces **70** and **74** sliding along their respective guide bar **76**.

With pilot fuel assembly **34** still in the position shown in FIGS. **4** and **5** (i.e., as far as it will go in the first direction toward boss surface **60**), a first measurement of the distance between boss surface **60** and flange surface **68** is taken (distance A in FIG. **4**). Pilot fuel assembly **34** is then moved as far as it will go in a second direction, opposite to the first direction and toward boss surface **64**. During this movement, flange surfaces **70** and **74** maintain sliding contact with their respective guide bars **76**. It is noted that while it is preferred to use two guide bars **76**, the method of the present invention can be carried out using only one guide bar **76**, as long as the corresponding flange surface is maintained in contact with the single guide bar **76** while pilot fuel assembly **34** is moved in the second direction.

The movement of pilot fuel assembly **34** as far as it will go in the second direction will place pilot fuel assembly **34** in the position shown in FIGS. **6** and **7**, with cylindrical body **38** in contact with circular aperture **50** at a point opposite that of FIG. **5**. A second measurement of the distance between boss surface **60** and flange surface **68** is taken at this position (distance B in FIG. **6**). Next, the average of the first and second measurements is determined, and pilot fuel assembly **34** is moved back in the first direction toward boss surface **60** so as to be located at a position where the distance between boss surface **60** and flange surface **68** is equal to the average of the first and second measurements, as shown in FIGS. **8** and **9**. Again, the movement of pilot fuel assembly **34** is done while maintaining sliding contact between flange surfaces **70** and **74** and their respective guide bars **76**. Accordingly, pilot fuel assembly **34** is now centered in both the axial and tangential directions and concentricity between pilot fuel assembly **34** and swirler assembly **44** is achieved. Lastly, pilot fuel assembly **34** is fastened to casing **24** with bolts **41**, and guide bars **76** are removed.

This method will provide concentricity between pilot fuel assembly **34** and swirler assembly **44** at cold assembly temperatures. During operation of the engine, these elements will be exposed to much higher temperatures and may thus move relative to one another due to differences in the amount of thermal expansion the elements will undergo. Thus, when centering pilot fuel assembly **34**, it may be necessary to include an offset to the position determined by the average of the first and second measurements which will account for thermal expansion. The offset will ensure that pilot fuel assemblies **34** are concentric when the engine is at its steady state operating temperatures.

FIGS. **10–15** show an alternative embodiment of a method for concentrically installing pilot fuel assembly **34** in combustor casing **24**. This alternative approach employs additional steps that are useful in the event that, while moving pilot fuel assembly **34** as far as it can go in the first tangential direction, the circular configuration of aperture **50** does not cause pilot fuel assembly **34** to become centered in the axial direction. In this case, pilot fuel assembly **34** is not fastened to casing **24** after being located at the position of FIGS. **8** and **9**. Instead, additional steps are carried out to assure that pilot fuel assembly **34** is centered in the axial direction after it has been centered in the tangential direction. In this alternative method, pilot fuel assembly **34** is first centered in the tangential direction using the same steps described above in connection with the method of the first embodiment. Thus, a description of these steps will not be repeated here. As noted above, centering pilot fuel assembly **34** in the tangential direction first is only for purposes of illustration; it is equally within the scope of the present invention to first center pilot fuel assembly **34** in the axial direction. Moreover, it is not necessary to center pilot fuel assembly **34** in the tangential and axial directions. Centering can be accomplished along any two perpendicular axes.

Once pilot fuel assembly **34** has been centered in the tangential direction in the manner described above, additional guide bars **78** are provided and first guide bars **76** are removed. One of the guide bars **78** is disposed in the gap defined by boss surface **60** and flange surface **68**, and the other guide bar **78** is disposed in the gap defined by boss surface **64** and flange surface **72**. Guide bars **78** have a width that matches the width of the gap in which they are disposed so that pilot fuel assembly **34** is prevented from moving in either tangential direction but is allowed to move in either axial direction by virtue of flange surfaces **68** and **72** sliding along their respective guide bar **78**.

Pilot fuel assembly **34** is now moved as far as it will go in a third direction, which is the forward axial direction toward boss surface **66** and parallel to boss surfaces **60** and **64**. The third direction is also perpendicular to the first and second directions. During this movement, flange surfaces **68** and **72** maintain sliding contact with their respective guide bars **78**. The movement of pilot fuel assembly **34** as far as it will go in the third direction will place pilot fuel assembly **34** in the position shown in FIGS. **10** and **11**, with cylindrical body **38** in contact with circular aperture **50** at the most forward point. With pilot fuel assembly **34** in this position, a third measurement, this time of the distance between boss surface **66** and flange surface **74**, is taken (distance C in FIG. **10**).

Pilot fuel assembly **34** is next moved as far as it will go in a fourth direction (the aft axial direction), opposite to the third direction and toward boss surface **62**. During this movement, flange surfaces **68** and **72** maintain sliding contact with their respective guide bars **78**. The movement of pilot fuel assembly **34** as far as it will go in the fourth direction will place pilot fuel assembly **34** in the position shown in FIGS. **12** and **13**, with cylindrical body **38** in contact with circular aperture **50** at its most aft point. A fourth measurement of the distance between boss surface **66** and flange surface **74** is taken at this position (distance D in FIG. **12**). Next, the average of the third and fourth measurements is determined, and pilot fuel assembly **34** is moved back in the third direction toward boss surface **66** so as to be located at a position where the distance between boss surface **66** and flange surface **74** is equal to the average of the third and fourth measurements, as shown in FIGS. **14** and **15**. Again, the movement of pilot fuel assembly **34** is done while maintaining sliding contact between flange surfaces **68** and **72** and their respective guide bars **78**. Accordingly, pilot fuel assembly **34** is now centered in both the axial and tangential directions and concentricity between

pilot fuel assembly **34** and swirler assembly **44** is achieved. Lastly, pilot fuel assembly **34** is fastened to casing **24** with bolts **41**, and guide bars **78** are removed.

Referring to FIG. **16**, a second structural embodiment is shown. In this embodiment, adjacent, circumferentially spaced pilot fuel assemblies **134** are disposed in adjacent openings formed in casing **24**. The mounting flange **140** of each pilot fuel assembly **134** is shown in FIG. **16**. The perimeter of mounting flange **140** defines an essentially circular shape but includes three flat surfaces, referred to herein as first flange surface **168**, second flange surface **170** and third flange surface **172**. Adjacent flange surfaces are perpendicular to each other. A T-shaped boss **125** is formed on the outer surface of casing **24**, with a wall thereof being located between the two flanges **140**. Boss **125** has four flat surfaces: first boss surface **160** and second boss surface **162** facing a first one of the flanges **140**, and third boss surface **164** and fourth boss surface **166** facing the other of the flanges **140**. First boss surface **160** is perpendicular to second boss surface **162**, and third boss surface **164** is perpendicular to fourth boss surface **166**, while first boss surface **160** is parallel to third boss surface **164**, and second boss surface **162** is parallel to fourth boss surface **166**. Preferably, parallel boss surfaces **162** and **166** are aligned so as to be parallel to the combustor casing's longitudinal axis, which means that boss surfaces **160** and **164** are tangential or perpendicular to the longitudinal axis, although this alignment could be reversed.

The method for concentrically installing the pilot fuel assemblies **134** with this embodiment is similar to the method previously described. Each of the two pilot fuel assemblies **134** are installed using the same method, so only the method for the assembly **134** on the bottom as shown in FIG. **16** will be described. First, pilot fuel assembly **134** is moved as far as it will go in a first direction substantially parallel to one of the boss surfaces **160** or **162**. For the purposes of illustration, the first direction is the axial direction toward boss surface **160** and parallel to boss surface **162**; however, it should be noted that the first direction can be in any direction that is parallel to one of the boss surfaces. Next, a guide bar (not shown) is disposed between boss surface **162** and flange surface **168**, and a first measurement of the distance between boss surface **160** and flange surface **170** is taken. Pilot fuel assembly **134** is then moved as far as it will go in a second direction, opposite to the first direction and away from boss surface **160**. During this movement, flange surface **168** maintains sliding contact with the guide bar. At this point, a second measurement of the distance between boss surface **160** and flange surface **170** is taken. Next, the average of the first and second measurements is determined, and pilot fuel assembly **134** is moved back in the first direction toward boss surface **160** so as to be located at a position where the distance between boss surface **160** and flange surface **170** is equal to the average of the first and second measurements. Again, the movement of pilot fuel assembly **134** is done while maintaining sliding contact between flange surface **168** and the guide bar.

Pilot fuel assembly **134** is now centered in the axial direction, and if it is accepted that the circular configuration of the aperture in the swirler assembly causes pilot fuel assembly **134** to self-center in the tangential direction, then concentricity between pilot fuel assembly **134** and its corresponding swirler assembly is achieved. If not, then the process can be repeated in the tangential direction wherein pilot fuel assembly **134** is moved back-and-forth parallel to boss surface **160** and towards and away from boss surface **162** (using a guide bar between flange surface **170** and boss surface **160**), with appropriate measurements being taken between flange surface **168** and boss surface **162**. Now, pilot fuel assembly **134** is centered in both the axial and tangential directions, and concentricity between pilot fuel assembly **134** and its corresponding swirler assembly is achieved. It should be noted that only two of the flange surfaces (**168**, **170**) are actually used in this process, and indeed the third flange surface **172** is not necessary to center pilot fuel assembly **134**. However, the use of three flange surfaces avoids the need of having two different pilot fuel assemblies, one for the right side and one for the left side.

The foregoing has described a method for concentrically installing a pilot fuel system in a combustor and combustor structure on which the method can be performed. While specific embodiments of the present invention have been described, it will be apparent to those skilled in the art that various modifications thereto can be made without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A method for concentrically installing a pilot fuel assembly in a combustor casing, said method comprising the steps of:

providing first and second flat surfaces on said combustor casing, said first and second surfaces being perpendicular to one another;

providing third and fourth flat surfaces on said pilot fuel assembly, said third and fourth surfaces being perpendicular to one another;

inserting said pilot fuel assembly into an opening in said combustor casing;

moving said pilot fuel assembly as far as it will go in a first direction substantially parallel to said first surface;

taking a first measurement of the distance between said second and fourth surfaces;

moving said pilot fuel assembly as far as it will go in a second direction, opposite to said first direction;

taking a second measurement of the distance between said second and fourth surfaces; and

locating said pilot fuel assembly at a position where the distance between said second and fourth surfaces is equal to the average of said first and second measurements.

2. The method of claim **1** further comprising the step of fastening said pilot fuel assembly to said combustor casing after said pilot fuel assembly has been located at a position where the distance between said second and fourth surfaces is equal to the average of said first and second measurements.

3. The method of claim **1** wherein the step of inserting said pilot fuel assembly into an opening includes orienting said pilot fuel assembly so that said first and third surfaces are substantially parallel to each other.

4. The method of claim **1** wherein said combustor casing has a longitudinal axis and said first surface is parallel to said axis.

5. The method of claim **1** wherein said combustor casing has a longitudinal axis and said first surface is perpendicular to said axis.

6. The method of claim **1** further comprising the step of placing a bar between said first and third surfaces and wherein said step of moving said pilot fuel assembly as far as it will go in a second direction includes maintaining said third surface in contact with said bar while moving said pilot fuel assembly.

7. The method of claim **1** further comprising the steps of:

providing fifth and sixth flat surfaces on said combustor casing, said fifth surface being parallel to said first surface and said sixth surface being parallel to said second surface;

providing seventh and eighth surfaces on said pilot fuel assembly, said seventh surface being parallel to said third surface and said eighth surface being parallel to said fourth surface;

placing a first bar between said first and third surfaces; and

placing a second bar between said fifth and seventh surfaces;

wherein said step of moving said pilot fuel assembly as far as it will go in a second direction includes maintaining said third surface in contact with said first bar and said seventh surface in contact with said second bar while moving said pilot fuel assembly.

8. The method of claim **1** further comprising the steps of:

moving said pilot fuel assembly as far as it will go in a third direction perpendicular to said first and second directions;

taking a third measurement of the distance between said first and third surfaces;

moving said pilot fuel assembly as far as it will go in a fourth direction, opposite to said third direction;

taking a fourth measurement of the distance between said first and third surfaces; and

locating said pilot fuel assembly at a position where the distance between said first and third surfaces is equal to the average of said third and fourth measurements.

9. The method of claim **8** further comprising the step of fastening said pilot fuel assembly to said combustor casing after said pilot fuel assembly has been located at a position where the distance between said first and third surfaces is equal to the average of said third and fourth measurements.

10. The method of claim **8** further comprising the step of placing a bar between said second and fourth surfaces.

11. The method of claim **10** wherein said step of moving said pilot fuel assembly as far as it will go in a third direction includes maintaining said fourth surface in contact with said bar while moving said pilot fuel assembly.

12. The method of claim **10** wherein said step of moving said pilot fuel assembly as far as it will go in a fourth direction includes maintaining said fourth surface in contact with said bar while moving said pilot fuel assembly.

13. The method of claim **8** further comprising the steps of:

providing fifth and sixth flat surfaces on said combustor casing, said fifth surface being parallel to said first surface and said sixth surface being parallel to said second surface;

providing seventh and eighth surfaces on said pilot fuel assembly, said seventh surface being parallel to said third surface and said eighth surface being parallel to said fourth surface;

placing a first bar between said second and fourth surfaces; and

placing a second bar between said sixth and eighth surfaces.

14. The method of claim **13** wherein said step of moving said pilot fuel assembly as far as it will go in a third direction includes maintaining said fourth surface in contact with said first bar and said eighth surface in contact with said second bar while moving said pilot fuel assembly.

15. The method of claim **13** wherein said step of moving said pilot fuel assembly as far as it will go in a fourth direction includes maintaining said fourth surface in contact with said first bar and said eighth surface in contact with said second bar while moving said pilot fuel assembly.

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